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Peers' Emotionality and Children's Academic Achievement in Second Grade: Testing the Moderating Role of Children's Behavioral Self-Regulation

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Abstract

Although there is interest in the role of peers in children's schooling experiences, few researchers have examined associations and related underlying processes between peers' emotionality, an aspect of temperament, and children's academic achievement. This study evaluated whether target children's ($N = 260$) own self-regulation, assessed with two behavioral measures, served a moderating function for associations between peers' emotionality and children's own academic achievement in second grade. There was a positive association between peers' positive emotionality and reading scores for children with higher self-regulation. Peers' negative emotionality was negatively related to target children's reading scores, particularly for children with higher self-regulation levels, but was unrelated to math scores. Peers' positive and negative emotionality did not predict math scores, and there was no strong evidence for the moderating role of target children's self-regulation in this association. This study highlights the potential role of children's self-regulation in modulating peer effects on academic achievement, particularly reading.

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Keywords

children's self-regulation; peers' emotionality; academic achievement

Students' academic achievement in elementary school has important implications for later academic milestones. For instance, research shows that academic achievement by the end of third grade predicts later educational attainment (The Annie E. Casey Foundation, 2010). This evidence has prompted researchers to investigate the predictors of academic achievement in elementary school to understand what factors might be modified early on to promote children's academic success. To this end, researchers have examined whether peer (e.g., Cooc & Kim, 2017; Justice et al., 2011; Mashburn et al., 2009) or individual characteristics (e.g., Kim et al., 2018; McClelland et al., 2014) predict academic achievement. However, studies testing the combined role of individual and peer characteristics in academic achievement are sparse.

Peer deviancy training is a key concept to understand how peer characteristics might relate to children's development (Dishion & Tipsord, 2011). The peer deviancy model suggests that peers socialize and reinforce each other's antisocial behaviors and attitudes through peer contagion; peer characteristics can be linked to children's developmental outcomes because of this socialization process. However, peer characteristics include more than antisocial behaviors and to understand peer training more broadly, we draw on the temperament research and its implications for children's academic achievement.

Temperamental dispositions, or "constitutionally based individual differences in reactivity and self-regulation, in the domains of affect, activity, and attention" (Rothbart & Bates, 2006, p. 100), are relevant for understanding children's social and academic development (Rothbart & Jones, 1998; Valiente, Swanson, & Lemery-Chalfant, 2012). Beyond other predictors of children's academic achievement (e.g., prior achievement), temperamental dispositions have demonstrated consistent associations with academic-related outcomes (Allan et al., 2014; Denham et al., 2012; Hernández et al., 2018; Hernández et al., 2017; McClelland et al., 2014; Sirotkin et al., 2013); children who are better able to regulate their behaviors might be better able to plan, problem solve, and engage in goal-directed behaviors (Blair & Raver, 2015). Peers' temperamental characteristics predict a range of other children's developmental (Dishion & Tipsord, 2011; Rodkin & Ryan, 2012) and academic outcomes (Cooc & Kim, 2017; Justice et al., 2011). In this study, peers' negative and positive emotionality are focal indices of peers' temperament reactivity and are examined as predictors of target children's achievement. In addition, target children's behavioral self-regulation (herein termed self-regulation) was examined as a moderator of the effects of peers' emotionality. Self-regulation has been defined as the "capability of controlling or directing one's attention, thoughts, emotions, and actions" (McClelland & Cameron, 2012, p. 136). Several tasks were used to assess top-down behavioral self-regulation, which involves the routine application of executive functions (e.g., attention regulation, inhibitory control, working memory), given its varying components (McClelland & Cameron, 2012; Nigg, 2017). Because of the multiple aspects of self-regulation (Nigg, 2017), we used

two measures of children's self-regulation: the continuous performance task (CPT) and Head-Toes-Knees-Shoulders (HTKS) task.

Children's self-regulation skills improve from preschool to primary school (Rothbart & Bates, 2006) as the school environment transitions to being more structured and focused on acquiring academic skills (Bassok et al., 2016). Although the association between children's behavioral self-regulation and academic skills seems stable across preschool and kindergarten (Allan et al., 2014), increased expectations for peer collaboration and opportunities for peer contagion processes suggest an increased relevance of peers' characteristics for children's school experiences. We focused our study on children in second grade because it is a time when there are increased expectations for collaboration with peers. For instance, writing comprehension and collaboration with peers are integral to the second-grade Common Core Standards in the U.S. (Common Core State Standards Initiative, n.d.). Examining peer and child predictors of academic achievement in second grade could inform our understanding of children's development before the third-grade transition, when self-regulatory and academic expectations increase in the school setting (The Annie E. Casey Foundation, 2010).

Peers' Emotionality Dispositions and Children's Academic Achievement

Peers are a part of a child's ecology and have a role in children's social and academic development (Bronfenbrenner & Morris, 2006; Dishion & Tipsord, 2011; Gifford-Smith et al., 2005; Rodkin & Ryan, 2012). Longitudinal and experimental studies support a deviancy training model to explain peer effects on antisocial behaviors in childhood (Gifford-Smith et al., 2005; Hanish et al., 2005) and adolescence (DeLay et al., 2016; Dishion & Tipsord, 2011; Gifford-Smith et al., 2005). Research has also demonstrated significant associations between peers' and their associates' academic skills (Mashburn et al., 2009), suggesting the presence of social learning and peer interaction effects in school contexts (Valiente et al., 2020).

Because children are more likely to have peers similar to themselves (DeLay et al., 2016), research on peer effects warrants consideration of whether associations between peer characteristics and child outcomes are due to peer selection. Research and theory on peer deviancy training suggest that peers socialize and reinforce each other's behaviors and attitudes beyond selection effects (Dishion & Tipsord, 2011; Gifford-Smith et al., 2005). Thus, *peers'* emotionality might also have implications for target children's academic achievement. We included target children's observed positive and negative emotionality as covariates in analyses to minimize possible peer selection effects.

Positive emotionality (e.g., happiness, excitement) attracts social interactions, maintains positive social interactions, and promotes children's social competence (Fredrickson & Cohn, 2008; Messinger et al., 2019; Yee et al., 2014). Positive emotion also has been linked to approach behaviors, increased exploration and creativity (Fredrickson, 2001; Silvia, 2019), and academic achievement (Denham et al., 2012; Hernández et al., 2016; Sirotkin et al., 2013). Evidence shows that peer collaboration during reading and math activities, potentially facilitated by positive emotion (Yee et al., 2014), promotes children's

learning (Fuchs & Fuchs, 2005). Thus, we generally expected peers' positive emotions to be positively related to children's academic achievement.

Difficulties with negative emotionality (e.g., sadness, anger) can shape how children interact in school (Valiente, Swanson, & Eisenberg, 2012). Children who express more negative emotions show relatively high levels of maladaptive behaviors (Valiente, Swanson, & Lemery-Chalfant, 2012) and lower levels of academic achievement (Denham et al., 2012; Valiente, Swanson, & Lemery-Chalfant, 2012). This line of research supports other findings suggesting that negative emotions limit attention and interest (Fredrickson, 2001), which have implications for school engagement and performance (Denham et al., 2012; Valiente, Swanson, & Lemery-Chalfant, 2012).

In addition to children's own negative emotionality predicting their academic achievement, peers' temperamental dispositions likely shape other children's school experiences and academic functioning. For instance, preschoolers with peers high in externalizing behaviors (which reflect high negative emotion and low self-regulation) were more likely to show externalizing behaviors themselves (Hanish et al., 2005). Because of the close inverse relation between negative emotionality and self-regulation, associations between classmates' and children's self-regulatory skills also suggest the presence of peer negative emotionality effects in school (e.g., Henry & Rickman, 2007; Johns et al., 2019; Montroy et al., 2016; Skibbe et al., 2012). Montroy et al. (2016) found that classroom peers' self-regulation predicted some academic achievement measures among preschoolers. Similarly, peers' self-regulation and kindergarten reading, but not math, scores were positively correlated (Johns et al., 2019). Peer support for self-regulated learning strategies (e.g., monitoring learning goals) also improved children's writing skills in second grade (Harris et al., 2006). Because peers interact with each other and model classroom behavior and norms (Valiente et al., 2020), peers' negative emotionality might similarly relate to their interaction partners' academic achievement. However, individual differences in children's sensitivity to their environment might attenuate or strengthen peer emotionality effects (Rothbart & Bates, 2006).

Children's Self-Regulation as a Moderator of Peer Emotionality Effects

Rothbart and Bates (2006) proposed that children's self-regulation interacts with their environment to shape development. That is, children's self-regulation might buffer against environmental stressors, including those in the peer context, or augment children's responses to their environment (Eisenberg et al., 2017; Rothbart & Bates, 2006). However, researchers have rarely tested the joint role of target children's and peers' temperament (see Johns et al., 2019, and Montroy et al., 2016, for exceptions). We hypothesized that children's self-regulation, which helps modulate behavior and attention, would moderate the associations between peers' emotionality and target children's academic achievement.

Assuming positive emotionality is positively associated with academic achievement when children are not overly aroused and dysregulated by the emotion (Denham et al., 2012; Fredrickson, 2001; Hernández et al., 2016; Silvia, 2019; Sirotkin et al., 2013), we might expect positive associations between peers' positive emotionality and target children's

academic achievement especially when target children are high in self-regulation. However, some evidence suggests positive emotions might undermine academic engagement and social adjustment when arousal and exuberance are elevated (Fredrickson & Cohn, 2008; Valiente, Swanson, & Eisenberg, 2012). For instance, children's positive expressivity is positively associated with externalizing problems (Rydell et al., 2003), risk-taking (Lahat et al., 2012), exuberance or impulsivity (Putnam, 2012), and negatively associated with school engagement for children with low self-regulation (Diaz et al., 2017). Thus, the strength and direction of effects for peers' positive emotionality on target children's academic achievement might depend on their ability to modulate their attention in high arousal peer situations. We might expect negative or nonsignificant associations between peers' positive emotion and target children's academic achievement when target children are low in self-regulation and have difficulties modulating their attention, given that elevated arousal and exuberance in positive emotions undermine academic and behavioral adjustment (Fredrickson & Cohn, 2008; Valiente, Swanson, & Eisenberg, 2012). In contrast, we might expect positive associations between peers' positive emotionality and target children's academic functioning for children skilled at self-regulation.

We predict children's self-regulation to moderate the relations between peers' negative emotionality and children's own academic achievement. Support for this prediction comes from two separate lines of research. First, researchers have identified significant interactions between children's self-regulation and their own negative emotionality when predicting behavioral problems or social competence (Eisenberg et al., 2017). For example, Diaz et al. (2017) and Valiente, Swanson, and Lemery-Chalfant (2012) found that children's negative emotions predicted lower academic engagement and teacher-student conflict for children with low or moderate self-regulation. The association between negative emotion and academic engagement or teacher-student conflict was not significant for children who exhibited high self-regulation. Second, based on Rothbart's theorizing (2006), better-regulated children, compared to less regulated children, might respond more adaptively or recover more quickly from the effects of their peers' negative emotions or unregulated behavior. However, at least two studies did not find significant interactions between target children's self-regulation and peers' negative emotionality when predicting target children's academic achievement (Johns et al., 2019; Montroy et al., 2016). Montroy et al. (2016) did not find that children's self-regulation moderated the association between peers' self-regulation, measured with an average self-regulation score from all classmates, and academic achievement in preschool. In a study involving kindergartners, the interaction between peers' negative emotionality and target children's self-regulation did not predict math or reading scores (Johns et al., 2019). These studies included preschool and kindergarten, when there is less emphasis on academic tasks than in second grade. Thus, there is a need to investigate these associations in older samples, given the increased importance of self-regulation and academic competence.

The Present Study

The present study extends research on peer effects by examining associations between the emotionality of proximal peers with whom children interact most and target children's math and reading achievement in second grade while controlling for target children's emotionality

and self-regulation. Prior research has indicated stronger associations between children's self-regulation and math than literacy outcomes (Allan et al., 2014; Hernández et al., 2018), emphasizing the need to examine reading and math separately. To our knowledge, researchers have not typically investigated whether children's own self-regulation might moderate how peers' temperament relates to a given child's academic achievement (see Johns et al., 2019, and Montroy et al., 2016, for exceptions). Given evidence that individual differences in self-regulation modulate experiences in the social environment (Eisenberg et al., 2010; Rothbart & Bates, 2006; Valiente et al., 2020), we extended common approaches to testing peer effects by considering target children's self-regulation as a potential moderator of prospective peer effects. Because of our interest in proximal peer processes (Bronfenbrenner & Morris, 2006) and prior research suggesting that the inclusion of at least two peers, compared to one peer, provides a more reliable indicator for peer effects (Ribeiro & Zachrisson, 2019), we conceptualized peers as the two classmates who spent the most time interacting with the target child. To minimize shared method variance, we included two behavioral measures of target children's self-regulation (McClelland et al., 2014; NICHD ECCRN, 2003) and standardized assessments of target children's academic achievement (Woodcock et al., 2001).

Guided by theory on the role of peers (Dishion & Tipsord, 2011; Gifford-Smith et al., 2005; Rodkin & Ryan, 2012) and children's self-regulation (McClelland et al., 2014; Rothbart & Jones, 1998) in academic development, we hypothesized that peers' positive emotionality would be positively associated with target children's academic achievement, especially for children with high levels of self-regulation. Because some evidence suggests unregulated positive emotion is associated with exuberance and higher levels of conduct problems (e.g., Lahat et al., 2012; Rydell et al., 2003), we tentatively hypothesized that peers' positive emotionality would be negatively associated with target children's academic achievement for children low in self-regulation. We hypothesized negative relations between peers' negative emotionality and children's academic achievement. We further hypothesized that these associations would be most pronounced for children with low levels of regulation. We controlled for children's demographic characteristics (e.g., sex, socioeconomic status) to provide a robust test of the hypothesized associations.

Method

Participants and Procedure

Participants in this study were part of a larger study of children's (N = 301) social and academic functioning. Children were recruited across two cohorts, one year apart, in a Southwestern metropolitan area in the United States from public schools at the beginning of the kindergarten school year. Of those who began the study, 260 children (49% male; M_{age} = 7.48 years) contributed data for the present study. Eighty-three teachers in 92 classrooms participated in the study (some teachers participated across the two cohorts). On average, 3 children participated per classroom (range from 1 to 13). Three children did not have peers' data because their teacher did not select any peer for them. Based on independent samples t-tests comparing covariates (Hispanic, age, sex, socioeconomic status), children who remained in the study did not differ from those who did not.

Consistent with the demographics of participating schools, study participants had varied ethnic and racial backgrounds (53% Hispanic, 34% White, 3% Asian, 2% American Indian/Alaska Native, 2% Black, 1% other, 6% unknown [rounded percentages]) and parental schooling levels. Thirty percent of mothers and 39% of fathers completed high school or less, 31% of mothers and 24% of fathers attended some college, and 39% of mothers and 37% of fathers graduated college. Participant recruitment occurred at the beginning of the kindergarten school year during curriculum nights, parent-teacher meetings, and via invitation letters sent in student backpack mailings that teachers used to distribute school information.

Research assistants contacted participants and their teachers before the beginning of second grade to continue participation in the study. Parents provided consent for their children's participation, and teachers provided consent for their participation. Research assistants obtained verbal assent from the target child individually before administering each assessment session, which took place in designated classrooms separate from students' regular classrooms to help minimize distraction. Research assistants received training (5 h of sessions per week for 5 weeks) prior to administering the self-regulation (McClelland et al., 2014; NICHD ECCRN, 2003) and standardized achievement assessments (Woodcock et al., 2001).

Based on prior research (Ribeiro & Zachrisson, 2019), second grade teachers chose two peers who spent the most time interacting with the participating target student in the classroom. Obtaining peer sociometric scores was not feasible given the larger goals of the study. As approved by the Arizona State University IRB, teachers identified target children's peers from either children participating in the study or, without disclosing their names, those not participating. Assessing peers' characteristics individually (e.g., "How aggressive is Peer #1?"), as opposed to generally (e.g., "Overall, how aggressive are this child's friends?"), has been recommended when using teachers' reports of peers (Gest, 2006). Thus, teachers completed surveys in the second grade fall semester, individually assessing each peers' positive and negative emotionality.

Similar to prior protocols (Fabes et al., 2001), a separate group of undergraduate student research assistants was trained across 3–4 weeks by graduate student supervisors and faculty to observe and rate children's negative and positive emotionality in school. As part of the training, observers rated child interactions in pilot preschools and pre-recorded interactions from a pilot preschool. Bi-weekly reliability checks were made for agreement with the coding supervisor. Observers rotated through a randomly ordered picture collage roster of participating children in each class, observed each child for 30-s, and recorded observation data with a pencil on paper scoring sheets attached to a clipboard with a stopwatch. Once the observer completed the roster, they began observing at the top of the roster. Observations of children's emotionality in the fall semester of second grade, conducted approximately 3 h a day, 2–3 times each week for 9–12 weeks, were included as covariates (see Appendix A for information on observational procedures).

Teachers received $5 in compensation for each survey completed assessing each peer's emotionality. Parents reported on target child and family background characteristics and

received compensation for each completed survey ($40). Children received a small toy for their participation in each assessment.

Measures

Given the prospective study design, we assessed target children's self-regulation and peers' positive and negative emotionality in the fall semester of the second grade school year. Reading and math achievement were assessed in the spring semester of the same school year, approximately four months after the fall semester assessment of the school year.

Reading and Math Achievement—Children's reading and math achievement were assessed in the spring semester of the second grade school year with the Woodcock-Johnson III Tests of Achievement (Woodcock et al., 2001). Although provided the option of completing assessments in Spanish, all students completed the tests in English. Passage comprehension and applied problem W scores, representing equal-interval units in a Rasch scale, were modeled separately in subsequent analyses.

Target Children's Self-Regulation

Continuous Performance Task.: Children completed a computerized continuous performance task (CPT; NICHD ECCRN, 2003) in the fall semester of the second grade school year. For this task, children sat in front of a computer. They were instructed to press a computer keyboard space bar as soon as a target stimulus (i.e., fish) appeared on the computer screen, but to refrain from pressing the keyboard space bar when one of eight non-target stimuli (e.g., boat, flower) appeared on the screen. Across all trials, 44 presentations of target stimuli and 176 presentations of non-target stimuli were randomly presented on the computer screen for 0.5 s, with 1.5 s intervals between stimuli.

All target children completed at least 75% of the trials, meeting the inclusion criteria in analyses. For each trial where the target stimulus appeared (i.e., a fish), a score of 1 was assigned for space bar press or a score of 0 for a missed space bar press; we computed the raw ratio of correct hits for target stimulus trials (i.e., hit rate). For each trial where the target stimulus did not appear, a score of 1 was assigned for a correct rejection (i.e., no space bar press) or a score of 0 for a false alarm (i.e., pressed space bar); we computed the raw ratio of incorrect hits for non-target stimuli trials (i.e., false alarm rate). The hit rate and false alarm ratios were individually converted into z scores. The difference between these two z scores, referred to as a detectability score, compares the means of the two distributions in a standardized metric and was used as a measure for how well children discriminate between target and non-target stimuli trials. Prior studies demonstrate strong psychometric properties for the CPT (Sulik et al., 2010).

Head-Toes-Knees-Shoulders.: In the fall of the second grade school year, children were administered the Head-Toes-Knees-Shoulders (HTKS) task, which has demonstrated strong psychometric properties (McClelland et al., 2014). In this task, 30 possible test trials were separated into three segments, each with 10 test trials (McClelland et al., 2007; McClelland et al., 2014). Before each of the three test trial segments was administered and scored, four practice trials were administered to familiarize the children with the task rules. Pre-recorded

trial instructions, demonstrated via a laptop, featured an experimenter requesting a given behavior from a child, after which the child was expected to perform a specific opposite behavior. If the requested behavior was that the child should touch their knees, the child was expected to touch their shoulders instead (and vice versa).

At least four correct test trials per segment were necessary to continue with the next trial segment. First test trial segment requests involved only touching shoulders and knees as opposite behaviors. The second test trial segment involved head and toes as opposite behaviors. In the third test trial segment, children were asked to touch their shoulders when the experimenter said toes and to touch their knees if the experimenter said head. Responses were coded based on the accuracy of requested behaviors: 0 (child performs wrong behavior and does not self-correct), 1 (child initiates wrong behavior but self-corrects), or 2 (child immediately performs correct behavior). Scores were summed across test trials and divided by 60 (the maximum possible score), representing a proportion of correct trials across all possible test trials.

Peers' Positive and Negative Emotionality—In the latter part of the fall semester of the second grade school year, teachers rated peers' positive emotionality (7 items; αs = .95; 1 = *very slightly or not at all*; 5 = *extremely*; see Appendix B for items), with the positive affect scale of the Circumplex Model of Emotion (Larsen & Diener, 1992). Peers' positive emotionality items were averaged for each peer and subsequently averaged between peers (r = .31, p < .001). Teachers also rated (1 = *extremely false*; 7 = *extremely true*) peers' anger (4 items; αs = .90) and sadness (8 items; αs = .91) based on the Children's Behavioral Questionnaire (CBQ, see Appendix B for items; Putnam & Rothbart, 2006). Peers' anger and sadness scale scores (rs = .77-.79, p < .001) were averaged for each peer to create negative emotionality scores. The negative emotionality scores, which were correlated between the target children's two peers, r = .38, p < .001, were averaged to create a score of peers' negative emotionality.

Background Covariates—Given prior research demonstrating associations with academic achievement (e.g., Henry & Rickman, 2007; Kim et al., 2018) or children's temperament (e.g., Johns et al., 2019; Montroy et al., 2016), we used target children's age, sex (0 = *female*; 1 = *male*), Hispanic ethnic background (0 = *Hispanic*; 1 = *non-Hispanic*), and family socioeconomic status (the average of the z scores of family income and parents' education) as covariates in all analyses. Data for these covariates were collected at study recruitment.

Research assistants observed children's emotional expressivity exhibited during school (e.g., lunch, recess, classroom) and rated (0 = *no evidence*; 3 = *strong evidence*) the intensity, frequency, and duration of negative (e.g., anger, frustration, sadness) and positive (e.g., pride, happiness, excitement) emotions after 30-s intervals (see Appendix A). In the fall semester of the second grade school year, children were observed by 2–3 observers (refer to procedure for training details). Observers' ratings for a given child were averaged across all observations for each emotion. Inter-rater reliability ratings obtained from a set of pre-coded videos (used for reliability purposes starting in the second year of the study) and randomly selected live scans, simultaneously rated by a second observer, were adequate

(ICCs = .95 [positive], .96 [negative]). We included observations of children's positive and negative emotionality in analyses with peers' positive and negative emotionality predictors, respectively, to account for possible peer selection effects. Observations of children's positive and negative emotionality, rather than teacher reports, were used to avoid shared method variance bias.

Analysis Plan

Analyses were conducted using M*plus* 8.1. All statistical models were performed using full-information maximum-likelihood estimation with robust standard errors (MLR estimator in M*plus*) to account for mild nonnormality and utilize all available data. The 'Type = Complex' command was used to account for non-independence of observations due to clustering of data by classroom in the second grade. Consistent with prior research (Nigg, 2017), HTKS and CPT scores were only modestly correlated. As a result, the HTKS and CPT scores were not averaged and instead used as separate measures of children's self-regulation. Including both assessments separately also provides sensitivity analyses of the relative robustness of effects across methods of assessment.

In separate models, we tested the hypothesized main effects from peers' positive or negative emotionality and target children's self-regulation (i.e., based on separate HTKS and CPT scores) to target children's math or reading achievement, controlling for background covariates (e.g., target child age, socioeconomic status). Second, we tested hypothesized interactions between target children's self-regulation (HTKS or CPT scores) and peers' positive or negative emotionality in relations with target children's math or reading achievement. For significant interactions, simple slopes analyses were tested at low (1 *SD* below the mean), average (at the mean), and high levels (1 *SD* above the mean) of target children's self-regulation.

Results

Descriptive Statistics and Correlations

Descriptive statistics and correlations for the study variables are displayed in Table 1. The variables did not display problematic levels of skewness or kurtosis. Peers' positive emotionality was significantly positively correlated with target children's reading and math achievement. Peers' negative emotionality was not significantly correlated with target children's reading and math achievement. Target children's HTKS and CPT scores were positively correlated with reading and math scores. Reading and math scores were below or close to the average for 8-year-olds (.45 *SD* below for reading, .15 *SD* below for math) and above average for 7-year-olds (.40 *SD* above for reading, .83 *SD* above for math), based on population estimates (McGrew & Woodcock, 2001).

To provide a relative comparison of the range of peers' emotionality, we compared the averages and variances of teacher reports of target children's and peers' emotionality. Teacher-reported peers' average negative emotionality ($M = 2.69$, $SD = 1.07$) was significantly lower than teacher-reported target children's negative emotionality ($M = 3.11$, $SD = 1.24$), $t(208) = 6.35$, $p < .001$; peers' negative emotionality was also less variable

than target children's negative emotionality, $F(225, 209) = 1.34$, $p = .02$. Teacher-reported peers' positive emotionality ($M = 3.36$, $SD = .66$) was comparable to teacher-reported target children's positive emotionality ($M = 3.41$, $SD = .94$), $t(208) = .938$, $p = .35$, but also less variable, $F(217, 209) = 2.07$, $p < .001$.

Main Effect Models Predicting Academic Achievement

In separate models testing predictors of reading or math achievement, peers' positive emotionality was not associated with reading scores (Table 2, Model 1). Peers' negative emotionality was significantly associated with lower reading scores (Model 2). Peers' positive and negative emotionality did not predict math scores (Models 3–4). Target children's self-regulation based on HTKS scores, but not based on CPT scores, was significantly associated with higher reading scores. Target children's self-regulation, based on CPT or HTKS scores, was positively associated with math scores.

Of the background covariates included, on average, males scored higher in math, Hispanic children scored lower in reading, and family socioeconomic status consistently predicted higher math and reading scores.

Target Child's Self-Regulation as a Moderator of Peer Effects on Academic Achievement

Separate models tested if children's self-regulation (CPT or HTKS) moderated the relations between peers' positive or negative emotionality and children's reading or math achievement. The interaction between peers' positive emotionality and target children's self-regulation significantly predicted reading scores (Table 3, Models 1A and 1B). The positive association between peers' positive emotionality and target children's reading scores was significant for target children with high self-regulation, marginal for those with average self-regulation, and nonsignificant for children with low self-regulation levels based on the CPT (Figure 1A). We found the same pattern of simple slopes for the HTKS measure (Figure 1B).

The interaction between peers' negative emotionality and target children's self-regulation based on the CPT (Table 3, Model 2A), but not the HTKS task (Model 2B), significantly predicted target children's reading scores. The negative association between peers' negative emotionality and target children's reading was most pronounced for target children with high, followed by average, levels of self-regulation based on the CPT (Figure 2).

The interaction between peers' positive emotionality and target children's self-regulation based on the CPT predicted target children's math scores at a marginally significant level (Model 3A in Table 3). The positive association between peers' positive emotionality and target children's math scores was significant for target children with high levels of self-regulation based on the CPT (Figure 3). The interaction between peers' positive emotionality and target children's self-regulation based on the HTKS did not significantly predict target children's math scores. The interaction between peer's negative emotionality and target children's self-regulation did not significantly predict math scores.

Discussion

The present study used a prospective design to examine the potential role of peers' temperamental dispositions in their classmates' academic achievement. Specifically, we tested whether peers' positive and negative emotionality were associated with target children's second grade math and reading achievement beyond prediction from target children's self-regulation, emotionality, and numerous demographic variables. Because children's self-regulation affects their responses to social environments (Eisenberg et al., 2010; Rothbart & Bates, 2006), this prospective study also expanded research on peer effects by examining the potential moderating role of children's self-regulation.

Consistent with our hypothesis, peers' positive emotionality was significantly associated with higher target children's reading scores when target children had relatively high self-regulation (based on the CPT or HTKS). These findings suggest that when children can modulate their attention, their peers' positive emotionality might help create learning opportunities, perhaps through increased exploration and creativity (Fredrickson, 2001; Silvia, 2019) or social competence (Fredrickson & Cohn, 2008; Messinger et al., 2019; Yee et al., 2014). There was inconsistent evidence for predicting math achievement; the interaction was marginally significant when self-regulation was assessed with the CPT and not significant when self-regulation was assessed with the HTKS. Based on some evidence that unregulated positive emotion is positively related to conduct problems (Lahat et al., 2012; Rydell et al., 2003), we tentatively hypothesized that peers' positive emotionality would be associated with lower academic achievement for children with low self-regulation. This relation was not identified. Our index of positive emotion likely did not reflect dysregulated positive emotion (e.g., exuberance) and instead assessed more prosocial positive emotion, which has been associated with affiliation with more prosocial peers (Eisenberg et al., 2006) and more positive social interactions with preschool peers (Fabes et al., 2012).

There was inconsistent evidence of a peers' negative emotionality by target children's self-regulation interaction. As shown in Figure 2, contrary to our hypothesis, peers' negative emotion was negatively related to target children's reading when target children were high and average in CPT assessed self-regulation. We expected to identify negative relations when self-regulation was low. Based on the study's results, more regulated children might have been more sensitive or attuned to their peers' negative emotionality, perhaps because they are more socially competent (Eisenberg et al., 2009) and aware of their peers' emotionality (Garner & Waajid, 2012). In this case, peers' negative emotionality might have been especially disruptive for reading experiences in the classroom. It is also possible that using teachers' reports of peers' emotionality, rather than sociometric ratings, might have resulted in scores that were more highly related to observations of negative emotionality during reading activities, which are typically delivered in groups (Castles et al., 2018). That is, peer dynamics might be more apparent in these types of group settings, which could have swayed teachers' perceptions of peers' negative emotionality due to comparison of more regulated target children. However, given that the interaction pattern for peers' negative emotionality did not replicate across the study's self-regulation measures and that these

findings contradict research suggesting that children's self-regulation buffers adverse peer effects (Dishion & Tipsord, 2011), caution should be exercised when interpreting this result.

Reading, compared to math, was more consistently predicted in interaction models. This pattern is interesting given that prior research has indicated self-regulation more strongly predicts children's math than literacy outcomes (Allan et al., 2014; Hernández et al., 2018). The association of peers' positive emotionality to reading for more regulated children might have been particularly consistent because children with higher self-regulation who interact with peers with higher positive emotionality have more opportunities to improve their verbal skills. Differences in early elementary math and reading instruction might also explain why our models more consistently predicted reading. For instance, group reading instruction is typical in elementary school (Castles et al., 2018), whereas math might involve more teacher-led instruction to the entire classroom. Children's self-regulation is likely more consequential in modulating potentially high-arousal peer settings during group-based reading instruction. These possible explanations require further study. Nonetheless, the interaction findings, which contributed an additional 1–2% of variance in reading or math, are small but noteworthy considering that other covariates in the model (e.g., socioeconomic status, self-regulation based on the HTKS) had larger effect sizes.

We measured target children's self-regulation based on the HTKS and CPT measures, given that these involve varying demands on executive functioning and gross motor behaviors (McClelland & Cameron, 2012). For instance, the CPT has a significant inhibitory control component during non-target stimuli trials and also requires working memory, attentional focus, and sustained attention (Sulik et al., 2010). In contrast, the HTKS requires modulating (i.e., initiating and inhibiting) gross motor responses given increasingly complex demands (McClelland et al., 2007). The degree to which target children's self-regulation measured with the CPT, compared to the HTKS, was a more consistent moderator of peers' negative or positive emotionality suggests that the CPT's inhibitory control and attentional focus might be particularly salient for modulating potential peer temperament effects. In addition, because HTKS was a strong predictor of achievement, there might have been less variance left in the outcome for a significant prediction from the interaction. Although future research is needed to corroborate our findings, the results suggest that children with higher attentional focus are more likely to benefit from their peers' positive emotionality and might be more attentive to their peers' negative emotionality, which has implications for reading outcomes in second grade.

Of the background covariates included, we found that on average, males scored higher in math, Hispanic children scored lower in reading, and family socioeconomic status was associated with higher math and reading scores. Although Hispanic children generally show increases in reading achievement in early elementary school, achievement gaps remain particularly for non-English speaking households (Reardon & Galindo, 2009), which is consistent with our findings. Prior research also demonstrates stable associations between socioeconomic status and academic achievement outcomes (e.g., Henry & Rickman, 2007; Kim et al., 2018), and a male advantage in math (Liu & Wilson, 2009). These findings further justify the inclusion of background covariates when estimating models of academic achievement.

Strengths and Limitations

The present study has several notable strengths in its design. We used a multi-method approach to assess the constructs of interest, which reduces possible shared method variance bias. Specifically, we used two measures of children's self-regulation (i.e., CPT and HTKS), teachers' reports to assess peers' temperamental emotionality dispositions, and a standardized measure of children's math and reading achievement. We were interested in predicting academic achievement before third grade, given its role in later educational attainment (The Annie E. Casey Foundation, 2010). We used a prospective design with predictors measured in the fall semester and academic achievement measured in the spring semester of the second grade school year. However, because all study variables were within the second grade and we did not include prior assessment of academic achievement as a covariate, future research should consider testing peer temperament-related academic effects in third and later grades with a longitudinal design.

Although sociometric data would have been optimal for identifying peers, a limitation is that they were not available in this study (and it is not clear if children differentiate between liking and degree of interaction with peers). Teachers' reports for identifying and assessing peers' temperamental dispositions are a useful alternative to sociometric methods (Gest, 2006; Ribeiro & Zachrisson, 2019). However, future research might assess peers' emotionality with multiple reports, including sociometric methods, parents' reports, and trained observers' reports. Other peer constructs of relevance not included in the study include the quality of peer interactions, such as how often peers interact with each other in academic tasks. Furthermore, because prior research has used classroom levels of student characteristics to assess peer effects, future research might test whether temperament dispositions at the classroom or proximal peer levels are most consequential.

Finally, we controlled for key background variables (e.g., socioeconomic status, sex) to estimate a relatively strong test of the associations of interest, a noted strength in the study's design. However, socioeconomic status based solely on family income and parents' education is a useful but limited proxy for resources that promote children's academic outcomes. Systemic factors related to disparities in school funding and resources, not accounted for in the study, shape the availability of socio-emotional learning or instructional resources that promote optimal learning environments. Lastly, we did not measure and account for instructional quality, which interacts with peer effects on academic achievement (Bulotsky-Shearer et al., 2014).

Conclusions

This study contributes to and extends research on peer academic effects by testing whether peers' temperament in the fall semester of the second grade school year was related to target children's academic achievement in the spring of the second grade school year. The study's findings highlight the potential role children's self-regulation has in how peers' positive emotionality and, in one instance, peers' negative emotionality relate to target children's academic achievement. Given that peers' positive emotionality was positively associated with reading scores for children with high self-regulation levels, implications include increasing opportunities for fostering prosocial positive emotionality among classroom

peers. Future research might consider how peers' emotionality relates to other academic-related processes, such as peer interactions during academic tasks.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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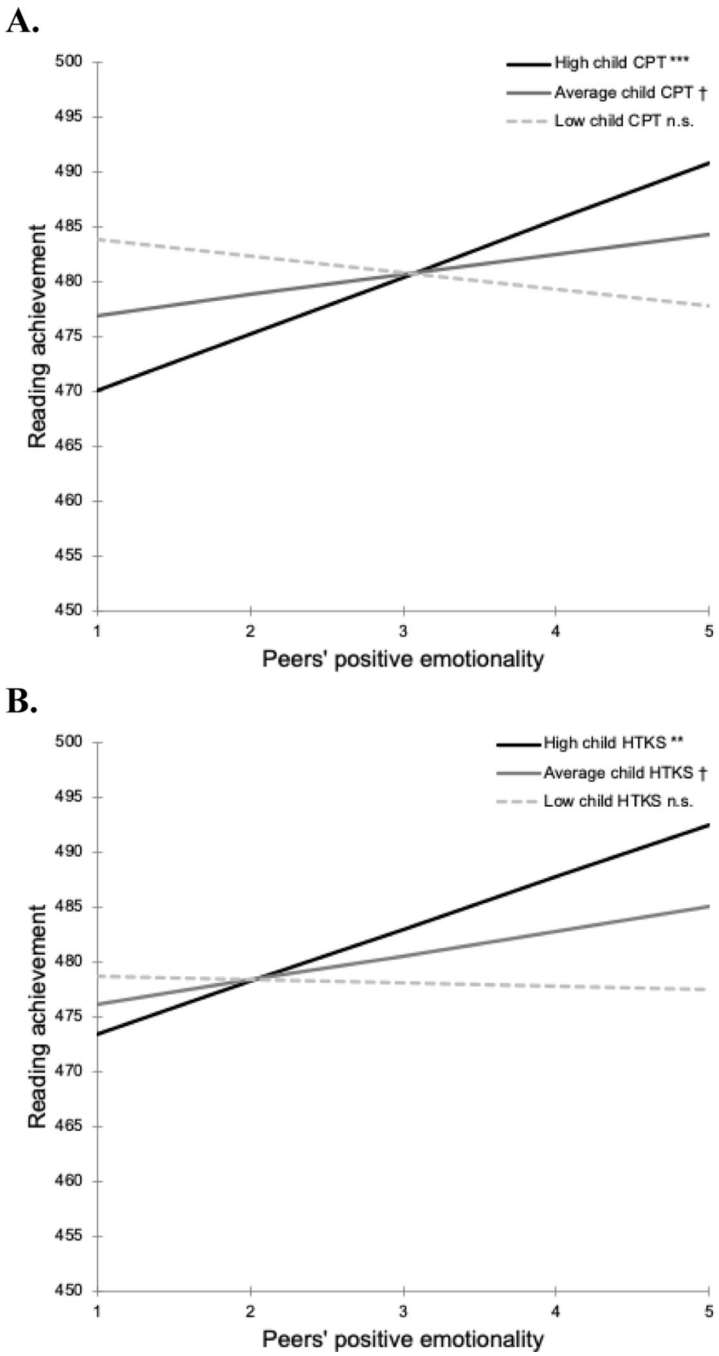

Figure 1. Interactions between Peers' Positive Emotionality and Target Child Behavioral Self-regulation Predicting Reading Achievement

Note. (A) Peers' positive emotionality predicted higher reading achievement for target children with average ($B = 1.83$, $p < .10$) and high ($B = 5.17$, $p = .001$) levels of self-regulation based on the CPT. (B) Peers' positive emotionality predicted higher reading achievement for target children with average ($B = 2.23$, $p = .07$) and high ($B = 4.75$, $p = .002$) levels of self-regulation based on the HTKS.

$^{\dagger}p < .10$, $^{**}p < .01$, $^{***}p < .001$.

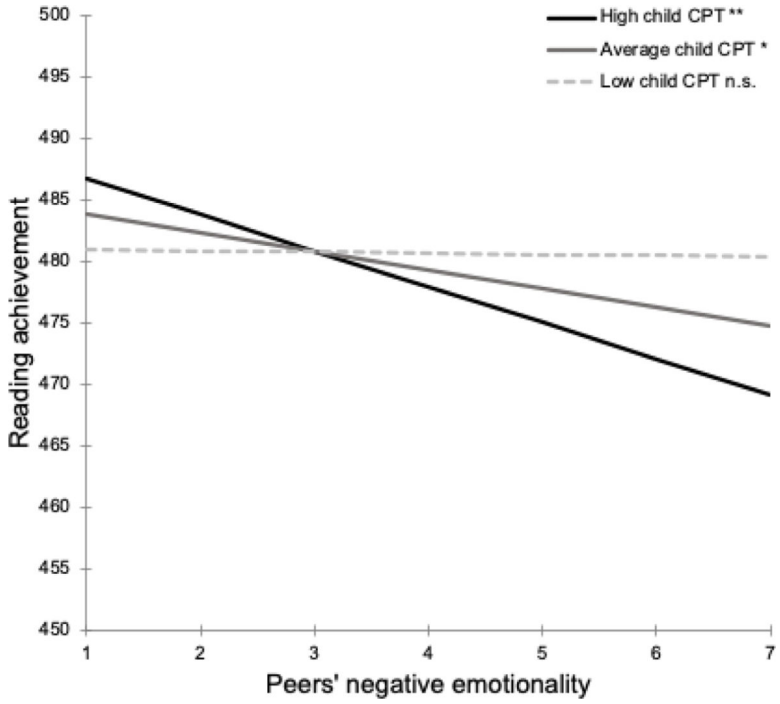

Figure 2. Interactions between Peers' Negative Emotionality and Target Child Behavioral Self-regulation Predicting Reading Achievement

Note. Peers' negative emotionality predicted lower reading achievement for target children with average ($B = -1.51$, $p = .02$) and high ($B = -2.92$, $p < .01$) levels of self-regulation based on the CPT.

*$p < .05$. **$p < .01$.

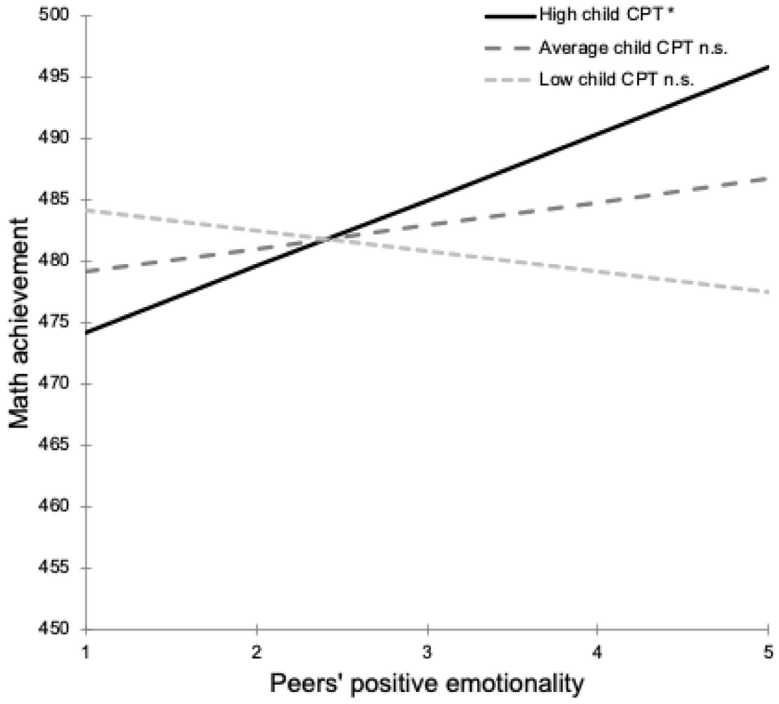

Figure 3. Interactions between Peers' Positive Emotionality and Target Child Behavioral Self-regulation Predicting Math Achievement

Note. Peers' positive emotionality predicted higher math achievement for target children with high levels of self-regulation based on the CPT ($B = 5.44$, $p < .05$).

*$p < .05$.

Table 1

Descriptive Statistics and Correlations among Study Variables

		1	2	3	4	5	6	7	8	9	10	11
1.	Reading achievement	--										
2.	Math achievement	.66***	--									
3.	Child self-regulation (HTKS)	.30***	.37***	--								
4.	Child self-regulation (CPT)	.13*	.21**	.23***	--							
5.	Child positive emotionality	−.11†	−.07	.02	.09	--						
6.	Child negative emotionality	−.05	.02	.08	−.04	.13†	--					
7.	Peers' positive emotionality	.17*	.15*	.11	.13†	−.08	.08	--				
8.	Peers' negative emotionality	−.06	.02	.02	−.05	.01	.13†	−.17*	--			
9.	Socioeconomic status	.45***	.47***	.22***	.15*	−.07	.10	.11	.16*	--		
10.	Male [a]	.09	.24***	.08	−.24***	−.07	−.16*	−.06	.12†	.10†	--	
11.	Age [b]	−.11†	−.05	−.10	.02	.00	−.05	.02	.03	−.10†	.12*	--
	M	481.05	481.51	0.83	3.43	0.92	0.07	3.36	2.69	−0.05	0.49	7.48
	Min.	420.00	427.00	0.00	−0.14	0.25	0.00	1.14	1.00	−1.83	0.00	4.27
	Max.	528.00	539.00	1.00	4.53	1.82	0.30	5.00	5.34	1.16	1.00	6.81
	SD	14.56	19.91	0.15	0.84	0.30	0.06	0.66	1.07	0.91	0.50	0.35

Note. CPT = continuous performance task score. HTKS = Head-Toes-Knees-Shoulders task score.

[a] Male (1 = *boy*; 0 = *girl*);

[b] Age in years at the beginning of the school year.

† $p < .10$,

* $p < .05$,

** $p < .01$,

*** $p < .001$.

Table 2

Main Effects Predicting Target Children's Reading and Math Achievement

	Reading Achievement		Math Achievement	
Parameters	***β***	***S.E.***	***β***	***S.E.***
	Model 1		**Model 3**	
Peers' positive emotionality	.08	.05	.06	.06
Child self-regulation (CPT)	.05	.06	.15**	.06
Child self-regulation (HTKS)	.21*	.08	.24***	.05
Child positive emotionality	−.07	.05	−.03	.06
Age	−.01	.07	.01	.05
Hispanic	−.22***	.06	−.09†	.05
Male	.01	.06	.20***	.06
Socioeconomic status	.29***	.06	.34***	.06
	R^2 = .30***		R^2 = .35***	
	Model 2		**Model 4**	
Peers' negative emotionality	−.10*	.05	−.05	.06
Child self-regulation (CPT)	.03	.07	.15**	.05
Child self-regulation (HTKS)	.23**	.07	.25***	.05
Child negative emotionality	−.09†	.05	.02	.05
Age	−.01	.06	.01	.05
Hispanic	−.22***	.06	−.10†	.05
Male	.00	.07	.21**	.06
Socioeconomic status	.33***	.07	.35***	.06
	R^2 = .30***		R^2 = .35***	

Note. CPT = continuous performance task score. HTKS = Head-Toes-Knees-Shoulders task score. Coefficients are standardized.

† $p < .10$,

* $p < .05$,

** $p < .01$,

*** $p < .001$.

Table 3

Interactions Between Target Children's Self-Regulation and Peers' Emotionality Predicting Target Children's Reading and Math

	Reading Achievement		Reading Achievement		Math Achievement		Math Achievement	
Parameters	***B***	***S.E.***	***B***	***S.E.***	***B***	***S.E.***	***B***	***S.E.***
	Model 1A		**Model 1B**		**Model 3A**		**Model 3B**	
Peers' positive emotionality	1.83†	1.10	2.23†	1.23	1.89	1.70	2.10	1.67
Child self-regulation (CPT)	1.20	1.11	0.96	1.08	4.00†	1.35	3.65**	1.19
Child self-regulation (HTKS)	22.35**	7.73	22.79***	5.65	34.27***	6.42	33.96***	6.37
Child positive emotionality	−2.98	2.24	−4.17†	2.28	−2.09	3.55	−3.15	3.35
Age	−0.32	2.80	−0.29	2.85	0.73	2.62	0.63	2.59
Hispanic	−5.77***	1.80	−5.99***	1.80	−3.10	2.05	−3.41†	2.05
Male	0.25	1.70	−0.08	1.79	7.79***	2.12	7.59***	2.21
Socioeconomic status	4.68***	1.02	4.39***	1.05	7.45***	1.45	7.26***	1.49
Peers' positive emotionality x child self-regulation (CPT)	3.98*	1.56	---	---	4.23†	2.57	---	---
Peers' positive emotionality x child self-regulation (HTKS)	---	---	17.43*	6.93	---	---	10.88	11.65
	R^2 = .31***		R^2 = .32***		R^2 = .36***		R^2 = .36***	
	Model 2A		**Model 2B**		**Model 4A**		**Model 4B**	
Peers' negative emotionality	−1.51*	0.65	−1.23*	0.62	−1.03	1.15	−0.84	1.13
Child self-regulation (CPT)	0.60	1.07	0.57	1.11	3.63**	1.21	3.60**	1.25
Child self-regulation (HTKS)	22.63**	7.17	22.59***	6.90	33.49***	7.52	33.38***	7.29
Child negative emotionality	−18.53	11.35	−19.58†	11.62	6.02	16.52	5.58	16.16
Age	−0.41	2.66	−0.28	2.60	0.66	2.88	0.75	2.86
Hispanic	−5.99***	1.80	−6.29***	1.87	−3.50†	2.12	−3.70†	2.09
Male	0.13	1.93	0.08	1.97	8.13***	2.35	8.09***	2.35
Socioeconomic status	5.45***	1.03	5.20***	1.08	7.88***	1.44	7.71***	1.44
Peers' negative emotionality x child self-regulation (CPT)	−1.69*	0.75	---	---	-1.19	1.13	---	---
Peers' negative emotionality x child self-regulation (HTKS)	---	---	-6.11	7.11	---	---	−3.65	9.24

	Reading Achievement		Reading Achievement		Math Achievement		Math Achievement	
Parameters	***B***	***S.E.***	***B***	***S.E.***	***B***	***S.E.***	***B***	***S.E.***
	R^2 = .32***		R^2 = .31***		R^2 = .36***		R^2 = .35***	

Note. CPT = continuous performance task score. HTKS = Head-Toes-Knees-Shoulders task score. Coefficients are unstandardized.

$^{\dagger}p < .10$,

$^{*}p < .05$,

$^{**}p < .01$,

$^{***}p < .001$.